

"Know the enemy, know yourself:

*Your victory will never be
endangered.*

*Know the ground, know the **weather**;
Your victory will then be total."*

Sun Tzu - The Art of War



INTRODUCTION

MOTIVATION: You may soon find yourself in a battalion or division command post briefing the colonel or general and his staff on the weather for a current or upcoming exercise. No one is going to tell you a whole lot about what information they want or how to present it. This period of instruction will give the tools to do a meaningful and professional job.



INTRODUCTION

REVIEW: In bootcamp you learned the structure and elements of a MAGTF. You also learned the primary missions of the Marine Corps. In Warfare Operations you practiced providing support to a joint Navy/Marine Corps operation. Here we will focus on specific Marine Corps requirements.



INTRODUCTION

OVERVIEW: This unit will give you insight into the Marine Air Ground Task Force's METOC requirements and the abilities of your METOC unit to supply them. We will cover METOC product production and briefings, and will end this unit with you giving METOC briefings to support the types of missions the Marine Corps is currently involved in.



Marine Air Ground Task Force (MAGTF)

Operations

4. Given an operational scenario and METOC data, prepare METOC products and present METOC briefings in support various MAGTF elements with at least 80% accuracy, based on an evaluation checklist.

Security

- Output
 - Paper
 - Electronic Media
- Hardware
 - Hard drives
 - Printer ribbons
 - Floppies

General METOC Impacts

- Force Impact
 - Each type of force is affected differently by METOC parameters
 - These parameters may determine which type force can be used

General METOC Impacts

- Intelligence
 - Weather data is used by commanders and staff in planning and conducting operations
 - Provides vital information for commanders to optimally employ their forces
 - This data is input into the Intelligence Preparation of the Battlefield process

General METOC Impacts

- Operational METOC support
 - Must be “on scene”
 - Affects all types of Marine operations
 - Operational Maneuver From The Sea (OMFTS)
 - Sustained Operations Ashore (SOA)
 - Other Expeditionary Operations (OEO)
 - Military operations other than war

METOC Support

- **Principles**

- Planning

- Weather must be considered by all tactical units during all planning and all operational phases
 - Commanders must consider both favorable and unfavorable weather to determine the best course of action

METOC Support

- Timeliness

- Accuracy of weather forecasts is dependent upon
 - Density and timeliness of weather observations
 - Observations must have high priority and be rapidly disseminated

METOC Support

- Communications
 - Must be timely and reliable
 - Need primary and alternate means
- Weather data is highly perishable
 - Must be monitored continually
 - Updated continuously

METOC Support

- Tasks and Responsibilities
 - Command Element (CE)
 - Has no organic METOC data collection assets or forecasting capability
 - Dependent upon the ACE for operational METOC support

METOC Support

- **CE Commander's responsibilities and tasks**

- Coordinate with ACE Commander to ensure that its operational METOC support requirements are met
- Provide logistical and communications support to attached Meteorological Support Team (MST)
- Integrate weather analysis into advanced planning
- Provide critical or threshold values for systems, tactics and operations
- Assess the impact of weather effects on "threat" weapon systems, tactics, and operations



METOC Support

- Ground Combat Element
 - GCE provides limited METOC support
 - Upper air data
 - Surface weather observations
 - » Forward Limited Observation Program (FALOP)
 - » Coded
 - » Refer to example in MCWP 3-29
 - Dependent upon the ACE for tactical METOC support

METOC Support

- **GCE Commander's tasks and responsibilities**

- » Coordinate with the ACE commander to ensure that its tactical METOC support requirements are met
- » Provide logistical and communications support to attached MST
- » Provide surface weather observations and all upperair data beyond the FLOT and relay the data back to the ACE



METOC Support

- » Provide critical values for determining the weather effects on GCE weapon systems, tactics, and operations
- » Assess the impact of weather effects on GCE weapon systems, tactics, and operations
- » Integrate weather planning into advanced planning
- » Provides trafficability and hydrographic forecasts



METOC Support

- Aviation Combat Element (ACE)
 - The ACE provides the bulk of weather support required by the MAGTF
 - Requires numerical products from the FLTNUMMETOCEN, regional center support, and access to both surface and upper air data from the Air Force, Navy and allied meteorological services, as well as the data furnished by the MAGTF.

METOC Support

- **The ACE Commanders responsibilities are**
 - Provide critical or threshold values for determining the weather effects on ACE weapon systems, tactics, and operations
 - Direct and coordinate all tactical METOC support requirements for each element of the MAGTF
 - Designate Marine Wing Support Squadrons (MWSSs) to provide MSTs to support each element as required
 - Provide METOC personnel with the technical training and skills necessary to support MAGTF operations



METOC Support

- Provide training for MAGTF personnel assigned to take limited weather observations in support of ACE operations
- Assess the general effect of weather on weapon systems, tactics, and operations based on critical values identified by each element
- Provide weather observations, forecasts, staff support and timely advisories or warnings of expected weather that may adversely affect MAGTF operations or that could be a hazard to personnel or material

METOC Support

- Ensure rapid dissemination of METOC products and services
- Provide weather support products for use in soil trafficability and hydrographical prediction
- Provide climatological support for tactical missions, Intelligence Preparation of the Battlefield (IPB) and tactical decision aids
- Provide light and tidal data

METOC Support

- Provide atmospheric and astronomical information affecting radar, wireless communication, and E-O weapon systems
- Provide liaison with Naval METOC centers for special requirements beyond inherent capabilities
- The METOC tasks required to be provided by the ACE means you. You must be able to provide all the products and information we just covered. You could take this section as a 6842 job description.



METOC Support

- Combat Service Support Element (CSSE)
 - The CSSE has no organic METOC data collection assets or forecasting capability. It is dependent upon the ACE for tactical METOC support
 - The CSSE Commander's tasks and responsibilities are
 - Coordinate with the ACE Commander to ensure that its operational METOC support requirements are met
 - Provide logistical and communications support to attached MST



METOC Support

- Integrate weather analysis into advanced planning
- Provide critical or threshold values for determining the weather effects on CSSE systems and operations
- Assess the impact of weather effects on CSSE systems and operations

METOC Support

- Requirements
 - Requirements for meteorological and oceanographic support vary between the operational and tactical level and between the CE, GCE, ACE, and CSSE

METOC Support

- The Command Element (CE) - at the operational level, the MEF headquarters requires forecasts of critical meteorological and oceanographic elements such as
 - Flying conditions
 - Surf
 - Current and tide conditions
 - Warning of extreme and dangerous weather conditions

METOC Support

- This information is required at least 72 to 96 hours in advance of an operation
- Forecasts of meteorological elements affecting communications are also required, such as
 - Extinction coefficients
 - Ionospheric disturbances
 - Refractive index
 - Temperature inversion levels

METOC Support

- The Ground Combat Element (GCE)
 - Marine Corps warfighting doctrine stresses expeditionary (and particularly amphibious) operations and is heavily maneuver-warfare oriented
 - The GCE requires a higher level of support
 - Requires METOC support in the form of graphic products
 - Used for briefing and decision aids
 - In the weather component of the IPB

METOC Support

- 24 to 48 hour general weather forecast are required which are focused on combat-related weather elements and sea data such as
 - Tide, current, and surf data
 - Beach slope, water depth, surf zone, and surf breaker description
 - Severe weather warnings
 - Horizontal visibility and obstructions to vision
 - Astronomical Data

METOC Support

- Precipitation rate and type
- Ambient air temperature and humidity
- Extreme heat or cold
- Surface wind speed and direction
- Cloud cover
- Freeze/thaw depth
- Ice/snow depth

METOC Support

- Wet Bulb Globe Temperature Index (WBGTI)
- Wind Chill index
- Pressure tendencies
- Upper air refractivity indices
- Upper air temperatures, winds, and heights

METOC Support

- The Aviation Combat Element (ACE)
 - Requires precise current weather information for every aircraft flight
 - Forecasts for the next 72 - 96 hours over a much wider area for operational planning
 - Aviation units are concerned with weather conditions
 - At widely dispersed departure airfields
 - Conditions enroute to destinations and targets

METOC Support

- Target areas
- Arrival/Bingo airfields
- Safe Haven/emergency eject area
- Refuel/Tanker area
- Forward Arming and Refueling Points

METOC Support

- The ACE requires precise aviation-related weather elements such as
 - Altimeter settings
 - Ceiling height
 - Pressure Altitude (PA) and Density Altitude (DA)
 - Cloud base/Cloud top height
 - Upper air temperatures, winds, and heights
 - In flight icing and turbulence conditions

METOC Support

- Combat Service Support (CSSE)
 - The CSSE's operations can be heavily influenced by extreme weather conditions
 - Extreme heat and cold can put added stress and strain on Marine Corps equipment and require
 - Additional maintenance
 - Spare parts
 - Affect the performance of personnel

METOC Support

- Heavy precipitation and severe weather may
 - Make outside storage difficult
 - Degrade the existing road system affecting mobility, trafficability, and construction efforts
 - Heavy icing or snow may make roads impassable
 - Create flooding or flash flooding conditions
 - Effect bridging operations due to high winds and strong water currents

METOC Support

- Unfavorable sea states make
 - Landing support more difficult
 - Logistics support to over the shore operations more difficult

METOC Support

- Concept
 - Upon the employment of a MAGTF, as part of a larger naval, joint or combined force, responsibility for the provision of tactical METOC support will transition from “garrison-based” to “on-scene” METOC support assets under the direction and control of the ACE

METOC Support

- Naval METOC Centers will retain responsibility for the provision of:
 - Weather facsimile support
 - METOC gridded field data
 - Wind, sea and tropical cyclone warnings and advisories
 - Area oceanographic support

METOC Support

- Tailored on-scene meteorological and oceanographic support is available from METOC assets organic to the ACE
- The MWSS, equipped with a METMF Complex, is normally deployed to a Forward Operating Base (FOB) in direct support of that airfield

METOC Support

- MSTs, from the MWSSs, are task organized to provide direct support to commanders and staff of MAGTF elements other than the ACE i.e.
 - CE
 - GCE
 - CSSE
 - MEU

METOC Support

- MAGTF elements should forward unique tactical METOC requirements, via the chain of command to the ACE vice requesting personnel and equipment directly.

METOC Support

- Capabilities
 - The MWSS weather section is internally organized and structured to support a variety of MAGTF and ACE specific operations/deployments
 - These organizations are manned and equipped to be utilized in a variety of ways contingent upon the size, scope and mission of the MAGTF

METOC Support

- Dedicated METOC support is available for all MAGTF elements from within the ACE
- A greater level of METOC support is normally required, and therefore dedicated to ACE operations

METOC Support

- These assets may be task organized to support a variety of operations and contingencies such as:
 - Meteorological Mobile Facility (METMF)
 - The highest level of METOC support to the MAGTF and particularly the ACE, is the deployment of the METMF
 - The METMF provides a METOC support capability similar to that found in garrison weather facilities and is normally deployed as part of an entire MWSS and is the only realistic option for Sustained Operations Ashore (SOA)



METOC Support

- Once established ashore, the METMF may forward base personnel and equipment in support of ACE units which are separated from the main air base
- This redeployment also provides the METMF with a forward data collection capability that significantly enhances overall support efforts to the entire MAGTF

METOC Support

- MEF Weather Support Team (MST)
 - Part of the MWSS T/O is dedicated to METOC support of elements other than the ACE (CE, GCE, CSSE and MEU)
 - MSTs are task organized to provide a limited level of support
 - Consist of a Weather Officer, two forecasters, and two observers
 - Directly attached to the elements they are tasked to support and rely upon that element for logistical and communications support

METOC Support

- MSTs do not have a “stand alone” capability
- During sustained operations ashore, they get their METOC products from the nearest deployed METMF



INTERIM SUMMARY



Prepare METOC products and present METOC briefings November 200

Weather Effects on MAGTF Operations

- Common Effects
 - Environmental elements tend to have different effects on different units and operations
 - But many can be identified as having similar effects on a majority of combat elements and operations.

Weather Effects on MAGTF Operations

- Use of climatology
 - Many of the common effects can be derived for planning purposes from the climate of the theater of operations
 - Special attention must be given to those elements of weather which may limit operations or preclude them altogether



Weather Effects on MAGTF Operations

- Planning
 - Very early in the planning process, planners must relate the possible courses of action to weather expectancies derived from climatological studies
 - There must be an acceptable likelihood that the weather conditions required for any proposed course of action will occur

Weather Effects on MAGTF Operations

- It is imperative that an operation be feasible meteorologically at the operational level of warfare, and that planning for seasonal weather changes be considered early in the planning process

Weather Effects on MAGTF Operations

- Weather and Terrain
 - When considering the effects of environmental conditions, the impact weather and terrain have on each other must be considered
 - Weather and terrain are so interrelated they must be considered together when planning ground and air operations

Weather Effects on MAGTF Operations

- Weather elements can drastically alter terrain features and trafficability
- Conversely, terrain features may exert considerable influence on local weather

Weather Effects on MAGTF Operations

- Weather Elements
 - Weather elements impact units and operations differently
 - They may aid or hinder the proposed mission
 - **Example: Low overcast with fog would provide concealment for a seaborne Recon team insertion**
 - **These same weather conditions would make CAS missions nearly impossible**

Weather Effects on MAGTF Operations

- Elements which must be considered are:
 - Visibility
 - Wind
 - Precipitation
 - Clouds
 - Temperature and Humidity
 - Severe Weather
 - Illumination and obstructions to vision

Weather Effects on MAGTF Operations

- Weather effects on specific types of operations
 - Lets quickly look at the weather effects on the types of operations listed in MCWP 3-29
 - These are general effects and you need to keep them in mind as you provide support to any of these types of operations
 - Next we will overview the specific critical meteorological values for each of these types of operations

Weather Effects on MAGTF Operations

- Meteorological Critical Values
 - These are the values which reduce significantly the effectiveness of tactical operations and/or weapon systems
 - Significant values above or below critical values can prevent the successful completion of a mission
 - Although weather personnel forecast and call attention to critical factors, only commanders decide which values are critical for each operation



Weather Effects on MAGTF Operations

- Additional information from the Naval Oceanographic Office, terrain analysis teams and other sources and the criticality of the mission are weighed by the commander in reaching a decision
- Let's now quickly overview the critical meteorological values listed in MCWP 3-29
- These values will become the basis for the weather impact decision aids you will produce and brief here at school and in the fleet

Munitions

- Iron (dumb) bombs
 - Basically consist of High Explosive and a set of fins to stabilize the fall
 - Method of delivery to target requires the pilot to point the aircraft at the target and release the bombs at the right dive angle and speed

Munitions

- Precision Guided Munitions
 - Glide Bombs
 - An Iron Bomb with parts added
 - Consists of High Explosive, Cruciform or Planar Wings, A seeker head, and Control Module to provide information from the seeker to the Wings to adjust the flight profile. May or may not have a data link to the aircraft.
 - Developed to provide a longer standoff range and hopefully increase pilot survival rates

Munitions

– Missiles

- A Glide Bomb with a propulsion section added
- Again the idea is to increase the standoff range. Some aircraft carried missiles have ranges out to 80 nm

Munitions

- Three types of precision guided munitions
 - This was covered in the consolidated portion of the course and is provided here for review
 - You should be able to relate these to employment modes

Munitions

- Employment Modes
 - Lock-on/launch/leave (LO/LA/LV)
 - May be used with any PGM and must be used with weapon systems for which there is no communication or data link between the munition and the aircraft
 - Compatible with passive, active, or semi-active systems

Munitions

- Launch/lock-on/leave
 - May be used with passive systems equipped with telemetry(data link). Can be used with laser munitions if the designator is collocated
 - Pilot must lase the target until weapons impact

Munitions

- Launch/leave/lock-on
 - May be used with passive systems equipped with telemetry and active and semi-active systems. Can be used with laser munitions in the buddy/remote designator mode
 - Pilot may egress immediately after weapons release if he does not have to lase the target

Munitions

- Munitions currently in the DOD inventory
 - Glide Bombs
 - GBU-15
 - GBU-10
 - GBU-12
 - GBU-16

Munitions

- GBU-24 A/B B/B
- GBU-28
- AGM-62 Walleye

Munitions

- Air to Ground Missiles (AGM's)
 - AGM-65 Maverick
 - AGM-130 (GBU-15 w/rocket attached)
 - AGM-84E Stand Off Land Attack Missile(SLAM)
 - AGM-114 Hellfire
 - AGM-123 SKipper(GBU-15 w/rocket motor attached)
 - AGM-84A HARPOON (ship killer)

Munitions

- Anti-Radiation Missiles
 - AGM-88 HARM (passive radar seeker)
 - AGM-45 Shrike

Munitions

- Air to Air Active Radar Missiles
 - Phoenix
 - AMRAAM (Advanced Medium Range Air to Air Missile)

Munitions

- Surface to Surface and Artillery Ordnance
 - Tube Launched Optically Tracked Wire Guided (TOW) missile
 - Copperhead (laser guided arty shell)

Target Acquisition Systems

- Components
 - Imaging system
 - Visual
 - Infrared
 - Forward Looking (FLIR)
 - Downward Looking (DLIR)
 - Narrow Field of View (NFOV)
 - Wide Field of View (WFOV)

Target Acquisition Systems

- Lasers
 - Designators
 - Receivers
 - Rangers
 - Spot Trackers
- Cockpit Display
 - Heads Up (HUD)
 - Heads Down (HDD)

Target Acquisition Systems

- Marine Corps Specific Aircraft/Systems
 - F18C/D Hornet
 - AN/AAS-38 Forward Looking Infrared (FLIR) Pod Contains two Subsystems, the FLIR and the Laser Target Designator/Ranger (LTD/R)

Target Acquisition Systems

- FLIR

- » Primarily used for targeting, and is sometimes referred to by pilots as the T-FLIR.
- » Has two fields of view, Narrow Field of View (NFOV) and Wide Field of View (WFOV)
- » Interfaces with the aircraft and its avionics systems through the aircraft mission computer
- » Provides the mission computer with accurate target line-of-sight pointing angles, angle rates.
- » Helps put conventional bombs or rounds on target.

Target Acquisition Systems

- LTD/R Laser Target Designator/Ranger. Contains two subsystems
 - » Laser Target Designator
 - a. Provides the laser spot for laser guided weapons
 - b. Provides the laser spot for the collocated laser ranger
 - c. Provides the laser spot for the Laser Detector Tracker (LDT) located in another pod

Target Acquisition Systems

» Laser Ranger

a. A passive system which receives the spot from the collocated designator to determine range to the target/object being illuminated

b. Very accurate with many applications



Target Acquisition Systems

- Thermal Imaging Navigation Set (TINS)
 - Used for low level nighttime navigation
 - May or may not be mounted along with the T-FLIR

Target Acquisition Systems

- AN/ASQ-173 Laser Detector Tracker/Strike Camera LDT/SCAM POD. Contains two subsystems, the Laser Detector and the Strike Camera
 - Laser Detector Tracker (LDT)
 - » Used to identify targets which are illuminated by either ground forces (MULE) or Co-operative aircraft (buddy lase)
 - » Target position data from the laser detector tracker is fed directly into the mission computer and used to provide weapon aiming and ordnance release information

Target Acquisition Systems

- Strike Camera

- » This camera is not a target acquisition device, but is mentioned here because it is part of the pod assembly
- » It can be slaved to the laser spot tracker or independently controlled by the mission computer
- » Photographic data from this system permits rapid assessment of damage after aircraft attacks

Target Acquisition Systems

- PGMs carried by the F-18C/D



Target Acquisition Systems

- AV8B Harrier Night Attack/ Radar version only
 - Navigation FLIR
 - Wide Field of View only
 - Used for navigation only, does not have the resolution necessary for targeting
 - Provides an automatically optimized image of the terrain ahead for viewing on the pilots heads up display (HUD)



Target Acquisition Systems

- ARBS AN/ASB-19(V) Angle Rate Bombing Set Contains a Dual Mode Tracker. These modes are TV (Optical), and Laser.
 - The ARBS can switch from one mode to the other without losing the target
 - The Laser Tracker follows the spot provided by ground or other aircraft
 - Optical (TV) Tracker acquires and locks on to targets which are television designated by the pilot

Target Acquisition Systems

- Laser mode provides reticle/crosshair type information to the HUD. TV mode puts an image on the “TV” screen in the cockpit
- Tracking information is passed from the dual mode tracker to the weapons delivery computer to compute weapons release and ordnance delivery information



Target Acquisition Systems

- PGMs carried by the AV8/B Harrier

Target Acquisition Systems

- CH-53E Super Stallion
 - Helicopter Night Vision System (HNVS)
 - Is a FLIR system
 - Is primarily used for navigation
 - Is a proven Platform on board the SH-60, SH-2, MH-47, UH-60, AND MH-60 helicopters.
 - The Marine Corps version uses a display and is not mounted to a helmet.
 - PGM's



Target Acquisition Systems

- AH-1W Cobra
 - Night Targeting System (NTS) -
Contains (3) subsystems
 - FLIR
 - Laser Designator/Range Finder -
which provides the spot for the
Hellfire missiles the Cobra can carry
 - Low Light TV (CCD-TV)

Target Acquisition Systems

- Telescopic Sighting Unit
 - Visual, direct view optics used with the TOW missile system.
 - Has a 2x or 13x power magnification option
- PGM's
 - HELLFIRE (laser guided) missile
 - TOW

Target Acquisition Systems

- UH-1N Huey - Navigation Thermal Imaging System (NTIS)
- Contains (2) subsystems
 - FLIR
 - Laser Rangefinder

Target Acquisition Systems

- Ground Forces

- **Modular Universal Laser Equipment (MULE)**
 - Used for range finding and illuminating targets for laser guided bombs, missiles or artillery shells.
 - You might find this equipment in use by forward observers, STA sections, Recon Teams as well as conventional infantry sections.
- **AN/TAS-4 Tow Night Sight** - This thermal (IR) sight can “see” in degraded conditions such as smoke, haze, darkness, foliage and camouflage.

Target Acquisition Systems

- AN/TAS-5 Dragon Night Sight - Comparable to the Tow Night Sight
- AN/TAS-6(AN/UAS-11) Night Observation Device, Long Range (NODLR)
 - Is based on the Manportable IR receiver.
 - When combined with the AN/GVS-5 hand held laser rangefinder this night sight can provide information to supporting artillery as well as night observation post capability.

Target Acquisition Systems

- Low Light Devices

- Starlight scope, NVG's. These systems make use of available light not thermal signature and can be supported by the EO software.
- SLAP program in GF MPL will provide predictions for light level lux illumination values
- For Marine Corps purposes .0022 lux separates high lux illum from low lux illum

Target Acquisition Systems

- The Marine Corps currently uses two types of NVGs
 - The AN/AVS-6 ANVIS is used by the C-130 and rotary wing aircraft for assault support
 - The MXU-180/U “CATSEYES” are used by Marine Corps fixed wing aircraft
- ANVIS-9 will eventually replace both ANVIS-6 and catseyes

Target Acquisition Systems

- Other

- Many tracked and armored vehicles have IR laser devices on them for target acquisition and ranging.
- There are also several types of handheld laser rangefinders or laser target designators which might be used, especially in joint operations. Talk to the units you are supporting.

Target Acquisition Systems

- Other Services PGMs and TA Devices
 - Your student text contains some of the systems in use by the USN, USA, and USAF
 - Be sure you familiarize yourself with them

INTERIM SUMMARY



Prepare METOC products and present METOC briefings November 200

METOC Support Products

- Electro Optical Tactical Decision Aids
EOTDA
 - Security
 - The relationship between IR, TV, and Laser ID numbers and specific system names is classified at the CONFIDENTIAL or SECRET level
 - This information is contained in Appendix B



METOC Support Products

- Data obtained from or directly related to classified information, when added to the output will cause the output to be classified at the level of the document from which it was taken
- Users should also take extra precautions to protect data if a particular location regularly uses a limited number of systems whose parameters and/or predicted ranges are classified

METOC Support Products

- Purpose

- To help make weapons upload decisions
- To support execution tactics



METOC Support Products

- Contrast

- May be either Visual or IR
- Inherent Contrast (C_o)- the actual contrast between two objects based solely on their properties (we usually use this term in reference to objects at the target site)
- Apparent Contrast ($C_{o(x)}$) - the contrast that a person or EO sensor detects at some distance(x) from the target scene



METOC Support Products

- Threshold Contrast - the smallest contrast that can be detected by a sensor or by the human eye
 - Visual Contrast
 - » For visual systems, contrast is defined as the difference in reflectance or albedo between target and background
 - » There are at least three ways visual systems use to acquire contrast



METOC Support Products

- » The primary thing to remember is that the amount of light being reflected from the target compared to the amount of light reflected from its background, will determine how well the sensor can find the target
- » Therefore shadows, direct light vs indirect light will have an effect on contrast and ranges

METOC Support Products

- IR Contrast

- » Infrared contrast is defined as a radiometric temperature difference between target and background
- » Radiometric Temperature - represents the energy lost by radiation and is the temperature and object would have if it were a black body
- » Because most objects don't radiate all their energy they may appear colder than they are



METOC Support Products

- » The thing to remember is that objects with low emissivities and high reflectivity (even though hot to the touch) may appear cold in IR sensors
- » For energy or light to reach the sensor from the target it must pass through a medium (the atmosphere)
- » As it passes through energy is absorbed and light is scattered. This degrades the image the sensor can “see”



METOC Support Products

- » The primary absorption at IR wavelengths is done by water vapor and droplets
- » Two terms will help to determine when significant degradation of IR will occur
- » Relative Humidity - roughly greater than 90% significantly large hazes form that can significantly degrade IR contrast transmission
- » Absolute humidity - (the total mass of water vapor molecules in a volume of air, measured by dewpoint) greater than 10g/m^3



METOC Support Products

- Environmental Effects on each portion of the EO spectrum
 - The information contained in your student text is a review and amplification of the information you covered in the consolidated portion of the course on this subject
 - It is essential that you understand these processes and how they effect the target, the atmosphere, and finally the sensor



METOC Support Products

- Try to visualize how each part of your forecast will effect these three things. When you can do that the EO output should make sense and you will be able to have confidence in the product and explain it to your user.

METOC Support Products

- Models

• Common Models

- All three TDAs (i.e., IR, TV, and Laser) have three models in common*
- Target model, transmittance model and a sensor performance model*
- Each of these models performs the same general task for each TDA but bases its calculations on the type of energy being transmitted*



METOC Support Products

- Target Model - In general this model calculates the strength of the electro-optical “signal” at zero range (the targets physical location)
- Transmittance model - The transmittance model calculates how much this signal (IR energy, reflected light or laser energy) is attenuated in transit from the target to the sensor.
- Sensor performance model - The sensor performance model evaluates the range at which the signal received by the sensor equals the threshold value for detection or lock-on.



METOC Support Products

- IR TDA models
 - Target Model
 - » Responds to the difference in radiance between target and background
 - » This radiance difference is converted into a temperature difference
 - » The model which does this temperature conversion is called the TCM2 (Target Contrast Model #2)



METOC Support Products

- » The thermal characteristics of the target are computed by this model and take into account solar load, input from the Sky radiation model, number of facets of the target, as well as the effects of evaporation, condensation sublimation and precipitation
- » The thermal characteristics of the background must also be calculated. Each of the 8 generic backgrounds radiate different signatures and must be modified by the use of the F7 key to be as representative as possible
- » You can see here how important your wind, sky cover and precip forecast are to the target model calculations



METOC Support Products

- » The displayed temperature of a target usually varies with the order in which a set of backgrounds is displayed.
- » You should always list the primary background surrounding the target first
- » The temperatures calculated for both the target and background depend on angles of viewing (depression and azimuth) and therefore, on range.
- » The greater number of pixels contained in the target scene the harder it is to resolve the target. The depression angle is going to decide if you are looking at the side of the target or at the top.



METOC Support Products

- Transmittance model
 - » Attenuation of longwave IR radiation propagating through the atmosphere is modeled in terms of four components of extinction: molecular, aerosol, precipitation and battlefield contaminants
 - » Through the Met input you have either input or selected the parameters necessary for the model to calculate this extinction
 - » The transmittance is accurately calculated at a range of 4 km. Transmittance values at closer ranges will be overestimated and values for ranges greater than 4 km will be underestimated



METOC Support Products

- Sensor Performance model - The sensor performance model determines at what range the actual signal received by the sensor equals the threshold signal for detection or lock-on
- IR Visibility
 - » IRVIS is the MRT detection range for an “average” FLIR viewing a target of “standard” size and inherent contrast in a moderately cluttered scene.
 - » Use detection ranges computed for off-menu and high-value targets with caution until feedback from aircrews has provided you with some bases for confidence.



METOC Support Products

- Sensor Height Adjustment
 - » If the aircraft flight level is above the maximum detection range, then detection will not occur
 - » Contrast changes with elevation, different elevations put different facets of the target in view
 - » There are cases where detection will not occur no matter how low the aircraft flight level is set. In these cases the output will show a “-1.0”



METOC Support Products

- Clutter

- » Not to be confused with NVG clutter
- » Clutter consists of two parts, IR scene complexity and Scene Thermal contrast
- » You select the scene complexity and the software will calculate the Scene thermal contrast
- » Clutter can have a significant impact on detection ranges. High clutter Vs low may decrease ranges by 30% at 20,000 ft
- » Be sure to enter all background in the target scene, even if only one can be an immediate background for your target



METOC Support Products

- MDT vs MRT

- » MDT (also called hot/cold spot or star detection) vs MRT (definite shape)
- » Conventional wisdom holds that MDT ranges are longer than MRT ranges, but this is not always the case as will be seen when we discuss the Delta-T trap

METOC Support Products

- The Delta-T Trap

- » Only one TDA output product combines all the information needed to assess weapon system performance. That product is range (detection or lock-on). The others tell only part of the story and are dangerous when used alone. They can help you to better understand the output
- » The variation in target, background, and hot/cold spot temperature will determine the range and depending on their relationship the output range may be MRT or MDT. Lets examine the three examples in your handout.



METOC Support Products

- » Lesson #1 - The same contrast does not necessarily yield the same range, even for the same target
- » Lesson #2 - Larger contrast does not necessarily yield longer range, even for the same target
- » Lesson #3 - Again the only true measure of performance is range



METOC Support Products

- TV TDA Models
 - General Model assumptions
 - » For partly cloudy conditions, ranges are computed for the case where the target scene is directly illuminated by the sun or moon and for the case when it is in cloud shadow
 - » Targets are modeled as horizontal on the background surface
 - » Backgrounds are modeled as a sloped plane, with the target either on the slope or at the base of the slope



METOC Support Products

- » The TV TDA consists of four components: a target contrast model (TCM), a broadband illuminance model, an atmospheric transmittance model (ATM), and a sensor performance model



METOC Support Products

- Target Contrast Model

- » Computes the inherent radiance (at zero range) for up to three "objects in the target scene: the target, its shadow and the immediate background"
- » The targets are modeled using high resolution geometries (HRGs), with each target having up to 68 facets, or planar surface components.

METOC Support Products

- Inherent Radiance

- » The inherent radiance of the target facets, the shadow, and the background are determined by the objects' reflectivities and the illumination to which they are exposed
- » This illumination has three components: direct, diffuse, and reflected
- » Because the TV TDA uses a sloped background model you can trick it when the sun or moon is below some object on the horizon



METOC Support Products

- » For example, if there are trees on the horizon when the sun is rising, set the background slope just above the sun's altitude and set the downward slope direction to due west. This will eliminate direct illumination from your target



METOC Support Products

- Broadband Illuminance Model
 - » Provides the source of light or illumination into the calculations
 - » As appropriate, four sources of illumination are taken into account: sun, moon, twilight sky, and night sky (including the stars)
 - » Direct illumination - Partly cloudy conditions or directly facing the sun or moon above the slope
 - » Diffuse Illumination - Cloudy, sun below the slope, target in shadow



METOC Support Products

- » Both direct and diffuse light will be reflected from the target and background
- » Target heading, position of sun and moon, slope and direction (either toward or away from the source) all effect illumination



METOC Support Products

- Illumination terms
 - » Twilight - during twilight when the sun's elevation is between -18 and 0 degrees, illumination is provided by diffuse sunlight. If the moon is above the horizon during twilight its contribution is added to the total illumination
 - » During the course of twilight, diffuse illumination from the sun varies by seven orders of magnitude. It is suggested that you run the TV model in Planning Mode with a time increment of 15 or 30 minutes during the twilight period so you are aware of the various illumination conditions and ranges that will arise



METOC Support Products

- » The average duration of twilight is one hour and forty five minutes
- » True night - the night sky illumination, which also arises from the entire sky dome, is obtained using the insolation model with an extraterrestrial illuminance of 0.000208 lux. This is the light that is provided only by the stars



METOC Support Products

- Sensor Performance Model (SPM)
 - » The SPM evaluates a signature for up to two pairs of objects in the target scene
 - a. Target vs background
 - b. Shadow vs background (if there is a shadow present)
 - » The objective of the SPM is to determine at what maximum range the target or shadow “signature” is sufficiently strong that the sensor can perform its function, either to detect or lock-on



METOC Support Products

- » This is the range at which actual signature is equal to the threshold value
- » Threshold value - the minimum amount of energy or light that the sensor must receive to “see” the target
- » As the source elevation varies, particularly at the beginning and ending of the day when the shadow is longer, the reported range may switch from one object pair to the other
- » This may appear as a large difference in the reported ranges from one time to the next in a Planning TDA



METOC Support Products

- » Night Vision Goggles(NVGs)
 - a. This TDA outputs the range at which the probability of detection is 50%
 - b. This is the only TDA product that makes use of the clutter parameter



METOC Support Products

- Laser TDA

- Considers two classes that operate at 1.06 mm

- » Laser Ranging

- a. May obtain ranges by lasing the target or the background near the target. The background will often yield greater ranges

- b. The designator and receiver are collocated



METOC Support Products

» Lock on

a. The designator illuminates the target The TDA predicts range or either the designator or the receiver. The distance of either the designator or receiver must be specified (This is not necessary for collocated systems)

b. The model will predict the other range



METOC Support Products

- » There are seven modes and they each provide a different output. As Marines you will primarily use modes (1) and (5)
- » The receiver threshold and designator power vary from system to system. Therefore different combinations can yield significantly different ranges



METOC Support Products

- Atmospheric Transmittance Model (ATM)
 - » Specified into two layers
 - » In all cases extinction increases with decreasing visibility
 - » Decreases with increasing visibility

METOC Support Products

- Aerosol Models

- » As can be seen relative humidities above 70% can decrease range rapidly
- » Snow - if reported will take priority over prevailing aerosol and is based on visibility values

METOC Support Products

- Sensor Performance Model (SPM)
 - » Calculates maximum range based on minimum discernible signal (MDS)
 - » MDS depends on the particular receiver and receiver temperature. Receiver temperature is computed from receiver height and air temperature
 - » Upper and lower temperature data are used. Depends on which layer the sensor is in
 - » The sensitivity of ranges to receiver height temperature is generally not large



METOC Support Products

- MET Input

- Battlefield-Induced Contaminants (BICS)
 - BIC is defined as the persistent pall of smoke and dust that sometimes covers areas where combat has occurred
 - When BIC is observed the user's aerosol selection should be from among the aerosol choices other than smoke (i.e., the user should chose the aerosol appropriate to the prevailing airmass) so the BIC and airmass degradation effects can be combined
 - When TAF forecast weather codes of FU, VA, DU, or SA, are input values, the EOTDA system turns on a flag

METOC Support Products

- These TAF code values should be used when either BIC or smoke are observed
- Encode the visibility that you believe would be present without BIC or the effect of BIC will be taken into account twice
- For aircraft operating using Visible, Laser, and Infrared (8-12 μ m) systems a “rule of thumb” of at least 30 seconds separation for aircraft to attack the same target would seem appropriate for nearly all cases

METOC Support Products

- On the otherhand, 90 seconds would seem adequate time for the settling of large particles under nearly all environmental conditions encountered in aircraft operations
- Forecasters need to use their technical knowledge, skill, and judgment in forecasting cloud drift, dissipation, etc., that could affect aircraft attacking targets in close proximity to each other

METOC Support Products

- Smokes

- The effects of three smokes are modeled in the Version 3 of the EOTDA
- Fog oil, hexachloroethane (HC), and white phosphorous (WP) at 50% relative humidity
- These smokes are primarily used for screening, due to their chemical properties they react differently with the atmosphere and spreadout and disperse differently
- Wind speed and direction as well as atmospheric stability are parameters which you must pay particular attention to



METOC Support Products

- Aerosol Model Selection -
Remember that the weather code in your TAF such as FG, will enhance or override your primary aerosol selection

METOC Support Products

- OPS Input

- Targets

- EOTDA version 3 supports 18 specific menu targets and 9 classes of generic (create your own) targets

- Generic targets

- There are 9 classes of generic targets
 - The use of the generic targets will require you to get some information from intell concerning everything from bridge width to paint color and type



METOC Support Products

- Refer student to EOTDA worksheet in student handout
- The last three classes of generic targets 7, 8, 9, are for targets that do not fit one of the other categories very well and you must be aware of the special properties of these targets

METOC Support Products

- Backgrounds
 - Use F7 key to find definitions for all the input parameters
 - This is where you will find the definitions for all the input parameters you get prompted for when using the F7 key

METOC Support Products

- Sensors

- A number of sensor data files are supplied with the EOTDA software
- These are considered the standard sensors and already have ID NUMBERS blocked out for them
- The software gives you the ability to create your sensors and Chapter 13 provides worksheets for each category of User Defined Sensor
- To obtain the necessary input you will have to consult operators, mechanics, pilots, manufacturers manuals, tech pubs etc.



METOC Support Products

- Output Range
 - Ranges are based on slant path
 - This effects output in several ways
 - » If the range is less than the slant path due to altitude the output will show minus one (-1)
 - » If the computed range is greater than the distance to the horizon the horizon distance will be displayed
 - » The model assumes cloud free line of sight if you forecast a broken deck below the sensor height. Think real hard about the probability of there being a hole over the target area at the Time on Target



METOC Support Products

- » In some cases it may be more realistic to forecast overcast and thus force the aviator to get under the cloud deck
- » If the sensor height is above an overcast the output will read -2
- In some circumstances, usually in IR, no solution is possible due to the thermal characteristics in the target scene along with the sensors capability. In this case the range output will be 0. But before you buy this double check your TAF input for missing digits, incorrect encoding etc.



METOC Support Products

- Software Problems with TAF input
 - Improper format or entering the wrong digits or letters can severely affect the models output
 - The software has a trick of hiding old or bogus TAF data at the bottom of the TAF input screen. Use the down arrow or page down key to inspect this area. You might be surprised at what you find
 - If the output numbers and ranges don't make sense based on your knowledge of the atmosphere and sensor in use, the problem is most likely your TAF input.



METOC Support Products

- F7 Key
 - Used to modify temperature and dew-point curve
 - Used to modify boundary layer and Aerosol data
 - Anytime you place the cursor over a data entry field try F7 to see if additional data modification is possible
- User Defined Laser Input
 - The values must be entered in the opposite order from which they are prompted
 - This was due to a mistake in the programming and should be corrected in future versions

METOC Support Products

- Geophysical Fleet Mission Program Library (GF MPL)
 - You will become familiar with the following software applications as you prepare your briefings in Marine Unique
 - Sound Focus Forecast (SOCUS)
 - This program forecasts the propagation of sound waves
 - Used to determine noise complaint or damage levels



METOC Support Products

- Radiological Fallout (RADFO)
 - This program forecasts the pattern and level of Radiological Fallout
 - The output may be used in some of the METOC messages we will discuss later

METOC Support Products

- Integrated Refractive Environmental Prediction System (IREPS)
 - You know how to interpret these products. Here you will learn to use the software to produce the products you have been using
 - Specifically you will learn to produce:
 - Cover products
 - Loss products
 - Platform Vulnerability products



METOC Support Products

- You will also cover
 - Historical Environmental Propagation Conditions (HEPC)
 - MET/EM Environmental Data File
 - Electro-Magnetic File (EMFILE)



METOC Support Products

- Radar Prediction Over Terrain (RPOTS)
 - Is the next generation of software beyond IREPS
 - Does just what its title suggests
 - Requires the use of digitized terrain CDs for the area of interest
 - Requires a very high speed and memory capable computer



INTERIM SUMMARY



Prepare METOC products and present METOC briefings September 200

METOC Support Products

- Weather Impact Decision Aids
 - The GCE requires METOC support in the form of graphic products that can be used for briefing and decision aids and for the weather component of Intelligence Preparation of the Battlefield
 - These products will be based on the “critical meteorological values” we discussed earlier



METOC Support Products

- You will use the standard color scheme:
 - GREEN (Favorable): no weather restrictions
 - AMBER (Marginal): weather degrades or limits
 - RED (Unfavorable): weather prohibits
- If using black and white media you must devise another scheme to represent the same three categories
- The focus of these briefings is to provide the commander information not just data



METOC Support Tasking and Planning

- Operations Plan or Operations Order
 - Every exercise, mission or battle has an op-plan or op-order. These are written in the five paragraph order (SMEAC) type format and describe the big picture of how the commander expects the battle to develop as well as the mission and tasking of each unit. This plan may be hundreds of pages thick (Desert Storm), or only a few pages

METOC Support Tasking and Planning

- You must be familiar with the overall plan so that you can determine
 - The types of units you will be supporting
 - The geographical location which you will be forecasting for
 - How weather can help or hinder the commander's mission
 - Contained within this order are some annexes which effect you as METOC personnel

METOC Support Tasking and Planning

- Annex H (Environmental Support)
 - Written in the SMEAC format
 - Details specifically how METOC forces will be used, from concept of operations to the tasks and responsibilities of each METOC unit involved

METOC Support Tasking and Planning

- Annex K
 - Contains the communications plan
 - Contains the EMCON procedures
 - Both of these factors will influence your ability to transmit data as well as your ability to get radar information
 - Get to know your communications officer and request a block of frequencies which should be usable for weather data transmission during the proposed exercise or operation time frame

METOC Support Tasking and Planning

- MAGTF Standard Tactical METOC Support Plan
 - This plan provides for a common baseline of standardized products and services to be provided at a minimum during MAGTF operations
 - These tactical products are tailored or modified as necessary by on-scene METOC forces to meet specific operational requirements and tactical situations

METOC Support Tasking and Planning

- Consists of the following three areas
 - OPTASK METOC
 - Operational tasks using NATO APP-4 standards to provide a standard message for the coordination of tactical METOC services and reporting responsibilities within a MAGTF
 - NOTE: You were briefly exposed to this in Warfare Operations

METOC Support Tasking and Planning

- Standard Tactical Summaries
 - These summaries are designed to provide minimum levels of METOC support to MAGTF elements during routine operations
 - Include the MAGTF Weather Forecast (WEAX), and Tactical Atmospheric Summary (TAS)
 - These support products are normally transmitted daily or as required

METOC Support Tasking and Planning

- WEAX

- Contains a Plain language meteorological synoptic situation
- Outlook to 48 hours for each METOC or operational zone of interest
- Astronomical data is included
- Radiological forecast is appended as required



METOC Support Tasking and Planning

- TAS

- Provides an atmospheric refractive summary
- Tactical assessment
- Electromagnetic sensor performance predictions
- Infrared detection range predictions
- Communication range predictions



METOC Support Tasking and Planning

- Special Tactical Summaries
 - These summaries provide minimum levels of tactical METOC support for specific operations and/or functions of Marine aviation
 - They include the Amphibious Area Objective Forecast (AOAFCST), Strike Forecast (STRKFCST), and Assault Forecast (ASLTFCST)

METOC Support Tasking and Planning

- AOAFCST
 - Designed to provide support for exercise/real world amphibious landings and rehearsals
 - Plain language meteorological situation
 - 24 hour forecast for the objective/landing area
 - Surf forecast for target beaches
 - Tactical assessment

METOC Support Tasking and Planning

- Abbreviated atmospheric summary
- Astronomical data
- Radiological and chemical fallout will be appended if the tactical situation warrants



METOC Support Tasking and Planning

- STRKFCST
 - Designed to provide a coordinated forecast whenever multiple strike (OAAW/SEAD/DAS) platforms (VMA/VMFA/VMAQ) are operating as an integrated force under one commander
 - Plain language meteorological situation
 - 24 hour forecast of enroute and target area weather
 - Outlook to 48 hours
 - Tactical assessment
 - Electro-optical sensor performance predictions

METOC Support Tasking and Planning

- ASLTFCST

- Designed to provide a coordinated forecast whenever multiple assault support platforms (VMGR/HMH/HMM/HMLA) are operating as an integrated force under one tactical commander
- Plain language meteorological situation
- 24 hour forecast of enroute, FARP/RGR and landing zone weather
- Outlook to 48 hours
- Tactical assessment
- Electro-optical sensor performance predictions

METOC Support Tasking and Planning

- METOC Briefings
 - Stand-up METOC briefings can be conducted to support operational or tactical objectives
 - A variety of medium can be used in preparing these briefs ranging from overhead transparencies to computer/electronic presentations



METOC Support Tasking and Planning

- Prior planning and coordination with G/S-2 and G/S-3 is recommended to ensure consistency, continuity, and appropriateness of the type of brief to be conducted

METOC Support Tasking and Planning

- Climatological Briefs
 - These briefs can be conducted for any geographical area or location of interest for any time of year
 - Normally conducted as part of pre-deployment work-ups to normal operations, exercises, or actual contingencies

METOC Support Tasking and Planning

- 24-48 Hour notice is normally needed to research material/references, collect, process, and prepare data for this type of brief
- Elements that are normally included but not limited to include
 - General Geography and Terrain
 - Oceanography
 - General Climate

METOC Support Tasking and Planning

- Historical Electromagnetic Propagation
- Electro-Optical Climatology (IR Band only)
- Astronomical Information
- Specific Weather Elements
- Assessment/ Impact to Planned Operations

METOC Support Tasking and Planning

- Operational Briefs
 - Normally conducted twice daily (morning/evening) or as necessary to support actual combat operations and exercises
 - METOC support objectives are established for this type of brief based on the combat element being supported, level of command, and the mission to be accomplished



METOC Support Tasking and Planning

- This brief will normally cover but not be limited to
 - Analysis of the current METOC situation
 - Forecast conditions out to 96 hours
 - Astronomical data
 - Impact assessment to planned Courses of Action (COA)/operations

- APPLICATION: Interspersed throughout the entire lesson.
- EVALUATION: Administer Progress Check at the end of the unit.